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MONTHLY WEIGHT AND BALANCE REPORT
FOR THE APOLLO SPACECRAFT
CONTRACT NAS 9-150
(U)

1 February 1963

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CLASSIFICATION CHANGE

To **UNCLASSIFIED**

By authority of *gds-120/116/12*

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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INTRODUCTION

This report has been revised to include a reference dimensional diagram of the Apollo spacecraft reflecting the spacecraft interface stations.

The center of gravity and inertia summary for the LOR mission reflects the injected weight providing 10 percent ΔV and propellant quantity based on a specific impulse of 319.5.

The major changes in the Command Module weight during January occurred in the heat shield structure due to reduced loads and revised load path concept. The weight of the ablation material was decreased per AVCO status.

The Service Module weight decrease is due primarily to the incorporation of an explosive bolt separation system, redesign of the supercritical oxygen tankage and supports, and utilizing a pyrotechnic shape charge for umbilical to the Command Module.

The launch escape system weight decrease is due to ballast reduction for a lighter Command Module.

The adapter weight has been decreased due to the deletion of the posigrade rocket installation.

The total spacecraft weight at injection decreased by 745 pounds and at Service Module burnout 255 pounds. The current injected weight of 82600 pounds is based on the Service Module loaded with sufficient propellant at a specific impulse of 319.5 to provide 10 percent ΔV margin. This is also based on a LEM weight, including crew, of 25,000 pounds.

The **Earth Orbital Mission Weight Summary** now reflects a two stage booster to orbit injection without the use of Service Module propulsion. This is now possible with the reduced spacecraft weight.

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APOLLO LOR MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. 2)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	9020	1044.0	0.7	7.7	4224	3622	3596
SERVICE MODULE - Less Propellant	9920	911.0	0.0	0.4	6645	10765	10625
TOTAL - Less Propellant	18940	974.3	0.3	3.9	10924	32480	32259
PROPELLANT - S/M**	36090	905.0	6.3	-2.7	18700	19750	25600
TOTAL - With Propellant	55030	928.9	4.2	-0.4	29835	65237	70846
LUNAR EXCURSION MODULE	24460	623.0	0.0	0.0	13616	12776	13247
ADAPTER - LEM - C-5	3110	640.1	0.0	0.0	6991	8649	8649
TOTAL - Injected	82600	827.4	2.8	-0.3	50514	453076	459227
LAUNCH ESCAPE SYSTEM	6430	1295.1	0.0	0.0	220	7864	7864
TOTAL - Spacecraft Launch	89030	861.2	2.6	-0.3	50744	742579	748740

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

**The propellant weight of 36090 pounds provides approximately 10% ΔV margin, and excludes 210 pounds of ΔV propellants tanked in the service module reaction control system.

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APOLLO EARTH ORBIT MISSION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. ²)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	9020	1044.0	0.7	7.7	4224	3622	3596
SERVICE MODULE - Less Propellant	9920	911.0	0.0	0.4	6645	10765	10625
TOTAL - Less Propellant	18940	974.3	0.3	3.9	10924	32480	32259
PROPELLANT - S/M**	2440	849.0	27.0	-11.7	770	500	600
TOTAL - With Propellant	21380	960.0	3.4	2.1	12139	40423	40521
ADAPTER - C-1	630	779.8	0.0	0.0	545	599	599
TOTAL - Injected	22010	954.9	3.3	2.0	12686	45313	45412
LAUNCH ESCAPE SYSTEM	6430	1295.1	0.0	0.0	220	7864	7864
TOTAL - Spacecraft Launch	28440	1031.8	2.5	1.6	12921	177509	177614

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

**The earth orbital weights are based on a complete service module and include 2,440 pounds of propellant for an orbital altitude of about 124 nautical miles with a payload launch azimuth of 720 without the use of service propulsion for injection.

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APOLLO LAUNCH ABORT CONFIGURATION

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

ITEM	WEIGHT POUNDS	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT. ²)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	9020	1044.0	0.7	7.7	4224	3622	3596
LAUNCH ESCAPE SYSTEM	6430	1295.1	0.0	0.0	220	7864	7864
TOTAL - Launch Abort	15450	1148.5	0.4	4.5	4492	62622	62548
LESS - MAIN AND PITCH MOTOR PROPELLANTS	-3230	1297.2	0.0	0.0	-69	-1398	-1398
TOTAL - LES Burnout	12220	1109.2	0.5	5.7	4405	41667	41669

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the command module substructure mold line.

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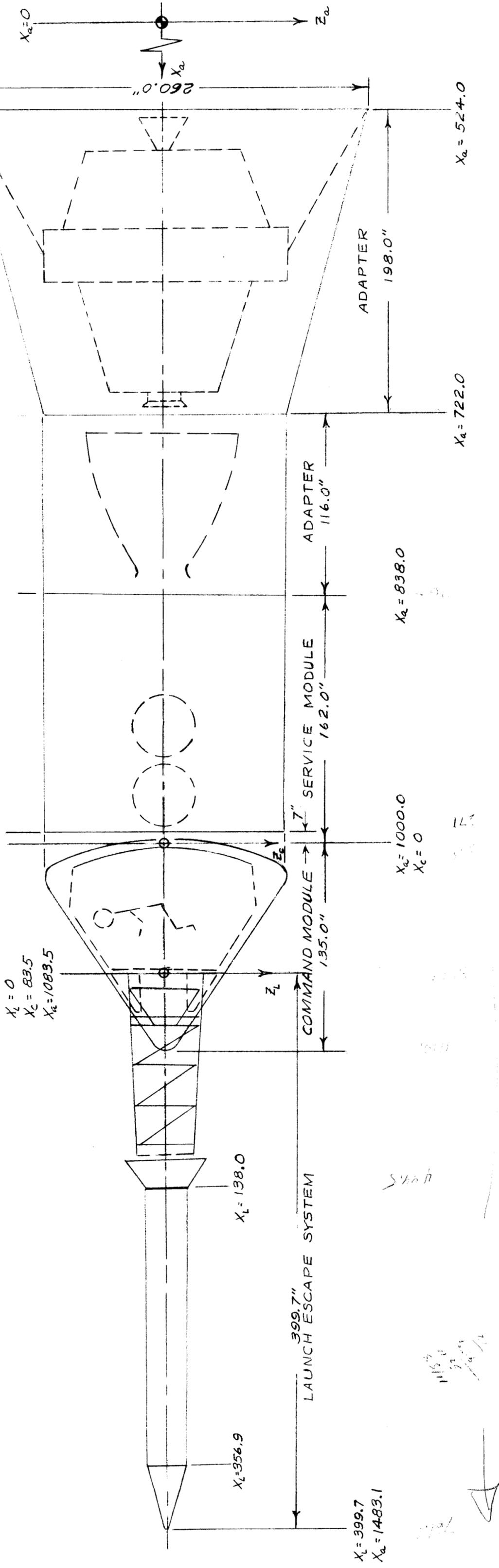
COMMAND MODULE

WEIGHT AND CENTER OF GRAVITY SUMMARY

VEHICLE CONFIGURATION	LAUNCH ABORT CONDITION			ENTRY CONDITION (LUNAR MISSION)				
	WEIGHT	X	Y	Z	WEIGHT	X	Y	Z
Earth Launch	(9020)	1044.0	0.8	7.8	(9020)	1044.0	0.8	7.8
Add: Unexpended Waste & Water	-	-	-	-	102	-	-	-
Shift Crew to Entry Position	-	-	-	-	-	-	-	-
Prior to Entry	-	-	-	-	(9122)	1043.9	0.3	9.5
Less: Propellant RCS	-	-	-	-	-242	1022.6	5.2	52.5
Ablation Material Burnoff	-	-	-	-	-283**	1019.7	0.0	11.2
Nose Cone & Discone Antenna	-409*	1099.6	-0.1	1.4	-381	1098.0	-0.1	1.4
Drogue Chute	-25	1090.0	11.0	-22.0	-25	1090.0	11.0	-22.0
Prior to Main Chute Deployment	(8586)	1041.2	0.8	8.2	(8191)	1042.7	0.2	8.6
Less: Main Parachutes (3)	-413	1092.0	0.0	8.6	-413	1092.0	0.0	8.6
Shift Crew to Land Landing Position	(8173)	1038.7	0.9	8.3	(7778)	1040.1	0.2	7.4
Landing								

*Represents nose cone with ablative material intact.
 **Based on 21% ablation burnoff.

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APOLLO VEHICLE DIMENSIONAL DIAGRAM

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SPACECRAFT
WEIGHT STATUS SUMMARY

ITEM	PREVIOUS STATUS 1-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 2-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
COMMAND MODULE	9170	-150	9020	65	33	2
SERVICE MODULE*	55025	-105	54920	11	89	
LES	6475	-45	6430	41	59	
ADAPTER	3260	-150	3110	100		
TOTAL	73930	-450	73480	24	76	-

NOTE: *Maximum capacity usable propellant of 45000 pounds included in status.

COMMAND MODULE WEIGHT STATUS

ITEM	PREVIOUS STATUS 1-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 2-1-63	BASIS FOR CURRENT		
				%EST.	%CAL.	%ACT.
Structure	4263	-231	4032	56	44	
Crew Systems	513	-1	512	100		
Communication and Instrumentation	889	-5	884	100		
Guidance and Navigation	431	-19	412	100		
Stabilization and Control	214	+19	233	100		
Reaction Control	267	+27	294	100		
Electrical Power	431	-14	417	100		
Environmental Control	262	+3	265	100		
Earth Landing	496	+60	556	20	55	25
WEIGHT EMPTY	7766	-161	7605	71	27	2
Crew (3) (50, 70, 90 Percentile)	528		528		100	
Suits and Personal Equipment	134	+2	136	100		
Survival Water	18		18		100	
Food and Containers	90		90	100		
Reaction Control Propellant	244	-2	242		100	
Environmental Control Chemicals	140	+11	151		100	
Scientific Payload	250		250	100		
GROSS WEIGHT	9170	-150	9020	65	33	2



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COMMAND MODULE

CURRENT WEIGHT EMPTY CHANGES

STRUCTURE		(-231)
Heat Shield Structure:		-89
Decrease honeycomb face sheets in forward and aft heat shield sections due to reduced loads and revised load path concept.	-66	
Decrease densified core in aft heat shield as part of Impact Attenuation System removal.	-20	
Decrease forward heat shield jettison fittings.	-5	
Increase honeycomb face sheets on crew hatch cover due to increased loads.	+15	
Decrease structural weight due to calculation of released drawings.	-13	
Inner Structure:		-6
Increase honeycomb bond weight due to redesign and re-orientation of honeycomb core.	+18	
Decrease aft sidewall longerons due to removal of Impact Attenuation System.	-20	
Decrease structure weight due to calculation of released drawings.	-4	

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COMMAND MODULECURRENT WEIGHT EMPTY CHANGES

Ablation Material:

-136

Decrease weight of ablator from 1484 to 1348 based on the 3 January 1963 Weight and Balance Report from AVCO. A comparison of the ablator weight for previous and current criteria for both the 5026-22 (58 Lb./Ft.³) and 5026-39 (35 Lb./Ft.³) ablative materials is as follows:

-136

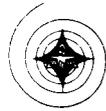
	PREVIOUS CRITERIA- 5026-22 ABLATOR	REVISED CRITERIA- 5026-22 ABLATOR	REVISED CRITERIA- 5026-39 ABLATOR
CRITERIA:			
Ablator Density (Lb/Ft ³)	58	58	35
Lift Off Temperature (+°F)	70	125	125
Face Temp. Pre-Entry (+°F)	50	250	250
Back Face Temp. After Touchdown (+°F)	600	600 (+)*	600 (+)*
Command Module Weight (Lb)	8500	9500	9500
Weight of Ablator (Lb):	1484	1650	1348

*The revised criteria stipulates the back face temperature may exceed 600°F after Command Module touchdown.

~~CONFIDENTIAL~~COM. AND MODULECURRENT WEIGHT EMPTY CHANGES

CREW SYSTEMS		(-1.0)
Reduce waste management system weight due to simplification of design by incorporating valves in solid design and eliminating ball valve fittings.		-7.0
Reduce water delivery assembly weight based on revised design estimate.		-0.5
Increase survival food consistent with requirements of one pound per man per day.		+2.0
Add personal head sets to be utilized during periods of shirt-sleeve environment per NASA letter No. 8567MA, dated 15 August 1962.		+4.5
COMMUNICATION AND INSTRUMENTATION		(-5.0)
Delete DSIF spare module and incorporate spare plug-in cards with the DSIF power amplifier and DSIF transmitter-receiver.		+1.0
Reduce the following component weights consistent with January Status from Collins:		-26.2
VHF-AM Transmitter	-4.3	
VHF-AM Transmitter-Receiver	-4.3	
PCM Telemetry Unit No. 1	-5.0	
PCM Telemetry Unit No. 2	-5.0	
Premodulation Processor	-7.6	
Incorporate antenna switch weight into antennas and transmission weight.		-4.2
Revise antennas and transmission weight estimate consistent with current requirements:		
VHF/2 - KMC OMNI Antenna and Transmission		+4.0
HF Recovery Antenna and Transmission		+15.0
C-Band Antenna and Transmission		+18.0
VHF Recovery Antenna and Transmission		+17.4
Antennas and Transmission		-30.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT WEIGHT EMPTY CHANGES

GUIDANCE AND NAVIGATION	(-19.0)
Revise the following component weight consistent with MIT January Status:	
Inertial Platform	-1.6
Navigation Base	-24.0
Computer	-42.0
Coupling Display Unit	+9.0
Add the following components per MIT January Status:	
Optical Base	+19.0
Eye Pieces	+5.0
Bellows and Adapter	+15.0
Revise NAA cabling weight consistent with current requirement.	+0.6
STABILIZATION AND CONTROL	(+19.0)
Revise the following component weights based on design coordination with Minneapolis-Honeywell:	
Rate Gyro Package	+1.0
Body Mounted Gyro Package	-4.5
Electronic Control Package - Pitch	-1.6
Electronic Control Package - Roll	-0.9
Electronic Control Package - Yaw	-2.6
Display/BMAG ECA Package	+15.3
Spare Gyro Rate	-0.2
Electronic Control Package - Aux (Added)	+30.5
Accelerometer (Deleted)	-5.0
BMAG Coupler (Deleted)	-13.0
REACTION CONTROL SYSTEM	(+27.0)
Add the following to improve system reliability:	
Expulsion Devices	+4.0
Plumbing and Fittings	+1.0
Valves and Regulators	+15.0
Increase engine weight consistent with Rocketdyne Status.	+7.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT WEIGHT EMPTY CHANGES

ELECTRICAL POWER	(-14.0)
Decrease Command Module to Service Module umbilical weight due to change from lower heat shield disconnect design to external side heat shield feed through employing a dead-end switch on critical circuits operating after separation.	-14.0
ENVIRONMENTAL CONTROL SYSTEM	(+3.0)
Transfer water glycol valves and disconnects to Service Module consistent with design drawings.	-3.0
Decrease water glycol component weights per Airesearch Status of 5 December 1962	-0.2
Increase pressure and temperature control components per Airesearch Status of 5 December 1962.	+0.1
Decrease re-entry oxygen supply system per Airesearch Status of 5 December 1962.	-2.4
Decrease water supply system weight per revised drawing analysis.	-0.3
Decrease weight of brackets, plumbing, electrical wiring per Airesearch Status of 5 December 1962.	-3.4
Increase instrumentation weight due to addition of power supply temperature transducer.	+2.2
Add weight allowance for subcontractor compliance with current radio noise suppression specification.	+10.0
EARTH LANDING SYSTEM	(+60.0)
Increase following component weights consistent with current Northrop-Ventura Status:	+70.8
Drogue Chute Housing	+2.5
Main Chute Cluster Designed to one second inflation time in lieu of four seconds.	+64.5
Pilot Chute System	+0.3
Sequence Control	+3.5

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~~CONFIDENTIAL~~COMMAND MODULECURRENT WEIGHT EMPTY CHANGE

EARTH LANDING SYSTEM (CONTINUED)

Delete shark repellent.	-1.9
Incorporate explosive bolt design in lieu of pyro-mechanical in the forward heat shield release system.	-8.9
	<hr/>
TOTAL COMMAND MODULE WEIGHT EMPTY CHANGES	-161.0

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~~CONFIDENTIAL~~COMMAND MODULECURRENT USEFUL LOAD CHANGES

Increase weight estimate of medical equipment consistent with present requirement.	+2
Decrease reaction control propellant to reflect current requirements.	-2
Increase freon coolant weight based on increased cooling loads.	+4
Add water for cooling during earth orbit.	+7
	<hr/>
TOTAL CURRENT USEFUL LOAD CHANGES	+11

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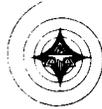
SERVICE MODULE WEIGHT STATUS

ITEM	PREVIOUS STATUS 1-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 2-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	2673	-50	2623	95	5	
Electronics	166		166	100		
Reaction Control	591	+8	599	100		
Electrical Power	1224	-73	1151	100		
Environmental Control	57	+21	78	100		
Propulsion System Engine Installation Propellant System	606 2456		606 2456	100 35	65	
WEIGHT EMPTY	7773	-94	7679	78	22	
Usable RCS Propellant	790		790		100	
Usable Supercritical Reactants	431	-20	411		100	
Environmental Control Fluids	202	+5	207		100	
Main Propulsion Helium	99		99		100	
Main Propellant Residuals Trapped - System Trapped - Engine Mixture Ratio Tolerance Loading Tolerance	(617) 225 67 100 225		(617, 225 67 100 225		100	
Unusable RCS Propellant	45		45		100	
Unusable Supercritical Reactants	68	+4	72		100	
BURNOUT WEIGHT	10025	-105	9920	60	40	
Main Propellant (Maximum Usable Capacity)	45000		45000		100	
GROSS WEIGHT	55025	-105	54920	11	89	

~~CONFIDENTIAL~~SERVICE MODULECURRENT WEIGHT EMPTY CHANGES

STRUCTURE	(-50)
Decrease separation system weight due to incorporation of an explosive bolt system in lieu of a mechanical system.	-50
REACTION CONTROL SYSTEM	(+8)
Decrease propellant tank weight consistent with reduced propellant volume.	-3
Decrease propellant expulsion system and supports due to smaller tanks.	-1
Decrease helium pressurization tank due to reduced volume.	-3
Increase quantity of following components to improve reliability:	
Plumbing and Fittings	+2
Check Valves	+2
Increase engine weight consistent with current vendor quotation of 4.3 pounds per engine including electrical leads.	+14
Decrease electrical provisions due to incorporation of electrical leads with each engine.	-3

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~~CONFIDENTIAL~~SERVICE MODULECURRENT WEIGHT EMPTY CHANGES

ELECTRICAL POWER	(-73.0)
Decrease hydrogen system components consistent with Beech Status.	-0.8
Decrease fuel cell and ECS Oxygen System weight due to the following:	-42.4
Incorporate Inconel 718 in lieu of Inconel -X in the supercritical tanks.	-26.0
Utilize space truss supports in lieu of cylindrical shell supports.	-11.4
Incorporate design utilizing higher preload on insulation resulting in reduced outer shell external pressure.	-4.2
Refine oxygen system valves and fittings.	-0.8
Add outer skin to fuel cell space radiator consistent with present requirements.	+9.4
Utilize a pyrotechnic shape charge on an external faired electrical harness in lieu of a pyro-actuated plug and connector for the Command Module to Service Module umbilical.	-38.7
Decrease power distribution supports based on revised estimate.	-0.5
ENVIRONMENTAL CONTROL SYSTEM	(+21.0)
Transfer water-glycol valves and disconnect from Command Module.	+3.0
Revise the following weights based on analysis revised drawings:	
Water System	+0.1
Oxygen System Disconnect Provisions	+0.4
Subcontractor Supports	+0.5
Add outer skin to environmental control radiator based on current requirements.	+17.0
TOTAL SERVICE MODULE CURRENT WEIGHT EMPTY CHANGES	<u>-24.0</u>

~~CONFIDENTIAL~~SERVICE MODULECURRENT USEFUL LOAD CHANGES

Decrease usable electrical fuel cell reactants based on electrical load reduction from 530 KW-hr. to 506 KW-hr.		-20
Hydrogen	-2	
Oxygen	-18	
Decrease unusable electrical fuel cell reactants based on revised estimates.		+4
Hydrogen	+1	
Oxygen	+3	
Increase environmental control system oxygen based on revised estimate.		+5
TOTAL SERVICE MODULE CURRENT USEFUL LOAD CHANGES		-11



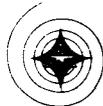
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LAUNCH ESCAPE SYSTEM

WEIGHT STATUS

ITEM	PREVIOUS STATUS 1-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 2-1-63	BASIS FOR CURRENT		
				%EST	%CAL	%ACT
Structure	1053	+19	1072	13	87	
Electrical System	20		20	100		
Propulsion System						
Main Thrust	4764		4764	50	50	
Jettison	440		440	1	99	
Pitch Control	55		55	75	25	
LES - NO BALLAST	6332	+19	6351	41	59	
BALLAST	143	-64	79	100		
TOTAL L.E.S	6475	-45	6430	41	59	

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~~CONFIDENTIAL~~LAUNCH ESCAPE SYSTEMCURRENT WEIGHT CHANGES

STRUCTURE	(+19)
Increase tower structure weight to include revised estimates for explosive bolts in the separation system.	+7
Increase flow separator and skirt assembly due to strengthening motor attach ring.	+8
Increase structure for miscellaneous changes resulting from calculation of released drawings.	+4
BALLAST	(-64)
Decrease ballast weight consistent with current combined Command Module and Launch Escape System requirements.	-64
TOTAL LAUNCH ESCAPE SYSTEM CURRENT WEIGHT CHANGES	-45

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ADAPTER

WEIGHT STATUS

ITEM	PREVIOUS STATUS 1-1-63	CHANGE TO CURRENT	CURRENT WEIGHT 2-1-63	BASIS FOR CURRENT		
				BEST	LOCAL	FACT
Structure	2892		2892			
Electrical	70	+6	76			
Separation System	142		142			
Posigrade Rocket (4)	156	-156				
TOTAL ADAPTER	3260	-150	3110	100		

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ADAPTER

CURRENT WEIGHT CHANGES

Delete posigrade rocket installation based on current design layouts. -156

Increase electrical provisions for revised estimates. +6.

TOTAL ADAPTER CURRENT WEIGHT CHANGES -150

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~~CONFIDENTIAL~~WEIGHT HISTORY COMMENTS

LAUNCH ESCAPE SYSTEM

The target weight established for the LES is 6,300 pounds, excluding ballast. This weight was based on the September status weight of 6,600 pounds including the necessary ballast to provide currently determined Aerodynamic stability to prevent tumbling.

The original target of 5,900 pounds as reported in the June Status, SID 62-99-5, was based on an attitude controlled configuration. The current configuration weight includes a flow separator, pitch motor, and ballast not included in the original target weight.

COMMAND MODULE

The target weight established for the Command Module is 8,500 pounds. An estimated weight breakdown for the target weight is provided for comparative purposes.

The original target weight of 8,340 pounds as reported in the June Status, SID 62-99-5, did not include the proposed increases nor the category I reductions presented in the July briefing and incorporated in the July Status Report.

SERVICE MODULE

The target weight established for the Service Module less usable propellant is 11,000 pounds. An estimated weight breakdown for the target weight is provided for comparative purposes. This configuration is sized for 45,000 pounds usable propellant for the 25,000 pound LEM.

The original target weight of 8,675 for the burnout condition was based on a lunar landing configuration sized for 31,000 pounds usable propellant.

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~~CONFIDENTIAL~~WEIGHT HISTORYCOMMAND MODULE

	ORIGINAL TARGET WT.	TARGET WEIGHT	AUTHORIZED CHANGES	AUTHORIZED WEIGHT 2-1-63
Structure	3670	3720		3720
Crew Systems	565	690	+2	692
Communication & Instrumentation	944	785		785
Guidance & Navigation	310	310	+86	396
Stabilization & Control	175	195		195
Reaction Control	183	195		195
Electrical Power	354	390		390
Environmental Control	228	255		255
Earth Landng	530	610	-106	504
WEIGHT EMPTY	6959	7150	-18	7132
Crew	528	528		528
Suits & Personal Equipment	82	126		126
Survival Water	54	18		18
Food & Containers	90	90		90
Reaction Control Propellant	210	210		210
Environmental Control Fluids	167	128		128
Scientific Payload	250	250		250
GROSS WEIGHT	8340	8500	-18	8482

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COMMAND MODULE WEIGHT HISTORY
WEIGHT EMPTY AUTHORIZED CHANGES

COMMUNICATION & INSTRUMENTATION	(+4)
Add a loudspeaker in the crew compartment per NASA request.	+4
GUIDANCE & NAVIGATION	(+86)
Increase the Guidance and Navigation per recent weight report from M.I.T. Since NAA does not have weight control responsibility for the M.I.T. Design, the weight changes in their Weight and Balance Report will be considered as authorized changes.	+86
EARTH LANDING	(-106)
The removal of the impact attenuation system per TRX SM 032, dated 23 July 1960 was reported in the 1 November 1962 Weight and Balance Report.	<u>-106</u>
TOTAL COMMAND MODULE WEIGHT EMPTY CHANGES	-18

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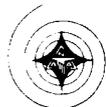
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WEIGHT HISTORY

SERVICE MODULE

	ORIGINAL TARGET WT.	TARGET WEIGHT	AUTHORIZED CHANGES	AUTHORIZED WEIGHT 2-1-63
Structure	2810	3203		3203
Electronics	216	145		145
Reaction Control	254	737		737
Electrical Power	1076	1203		1203
Environmental Control	413	250		250
Propulsion System Engine Installation	375	606		606
Propellant System	1928	2456		2456
WEIGHT EMPTY	7072	8600		8600
Usable RCS Propellant	400	611		611
Usable Fuel Cell Reactants	380	479		479
Environmental Control Fluids	288	193		193
Main Propulsion Helium	97	139		139
Main Prop. Residuals	300	900		900
Unusable RCS Propellant	20	61		61
Unusable Fuel Cell Reactants	38	17		17
BURNOUT WEIGHT	8595	11000		11000
Main Propellant	31000	45000		45000
GROSS WEIGHT	39595	56000		56000

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~~CONFIDENTIAL~~POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGESCOM AND MODULE

STRUCTURE	(-198)
Decrease ablator weight to agree with the target weight defined in the current ablative panel procurement specification.	-248
Increase upper heat shield ejection provisions due to increase in weight of structure assembly ejected.	+20
Add Aerodynamic strake based on recommended solution to the two point stability problem.	+30
STABILIZATION AND CONTROL	(+15)
Increase -H electronic control amplifier for incorporation of signal ground isolation.	+15
SCIENTIFIC EQUIPMENT	(-200)
Decrease scientific equipment weight at launch based on NASA comments that this equipment will likely be located in the LEM.	-200
LEM INTEGRATION	(+220)
Modify structure to incorporate mating and locking capabilities and to strengthen hatch for mating impact loads.	+90
Add electrical provisions for power distribution and control for LEM system activation.	+20
Add in-flight test wiring for LEM checkout.	+25
Modify Z&MC OMNI antenna and relocate.	+28
Add rendezvous beacon radar installation as an aid during the rendezvous phase.	+25
Add cooling water for subsequent transfer to the LEM.	+32
EARTH LANDING SYSTEM	(-105)
Increase parachute supports and attach structure to be compatible with increased structure loads imposed by the current ringsail parachutes.	+3

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~~CONFIDENTIAL~~POTENTIAL WEIGHT AND CENTER OF GRAVITY CHANGESCOMMAND MODULE

EARTH LANDING SYSTEM (CONTINUED)

Decrease parachute weight consistent with incorporation of solid conical parachutes.	-105
Decrease parachute supports and attach structure due to reduced structure loads imposed by the proposed solid conical parachutes.	-3
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TOTAL COMMAND MODULE POTENTIAL WEIGHT CHANGES	-268
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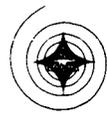
PCTENTIAL WEIGHT AND C.G. CHANGES

POTENTIAL WEIGHT CHANGES	
STRUCTURE	(-64)
The removal of insulation from the radial beams may result from current Thermodynamics analysis.	-64
USEFUL LOAD	(-35)
Revise loading tolerance weight to reflect the volume of propellant required for the lunar mission.	<u>-35</u>
TOTAL POTENTIAL WEIGHT CHANGES - SERVICE MODULE	-99

~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULESUMMARY

ITEM		CURRENT WEIGHT 2-1-63
<u>WEIGHT EMPTY</u>		7605
Structure	4032	
Crew Systems	512	
Communication & Instrumentation	884	
Guidance & Navigation	412	
Stabilization & Control	233	
Reaction Control	294	
Electrical Power	417	
Environmental Control	265	
Earth Landing	556	
<u>USEFUL LOAD</u>		1415
Crew Systems	772	
Reaction Control	242	
Environmental Control	151	
Scientific Payload	250	
GROSS WEIGHT		<u>9020</u>

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULESTRUCTURE

ITEM	CURRENT WEIGHT 2-1-63
<u>STRUCTURE</u>	
Heat Shield	(1281)
Forward Compartment	168
Crew Compartment	639
Aft Compartment	474
Inner Structure	(964)
Forward Section	208
Forward Sidewall	354
Aft Sidewall	206
Aft Bulkhead	196
Secondary Structure	(253)
Ablation Material	(1348)
Microfiber Insulation	<u>(186)</u>
TOTAL STRUCTURE	4032

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECREW SYSTEMS

ITEM	CURRENT WEIGHT 2-1-63
<u>CREW SYSTEMS</u>	
Personal Radiation Dosimeter (NASA)	5.0
Portable Life Support System (2) (NASA)	60.0
Personnel Communications (NASA)	5.0
Seat Liners & Restraint Harness	36.0
Sleeping Restraints	4.0
Waste Management	18.0
Lighting System	15.0
Garments - Constant Wear (NASA)	9.0
Water Delivery Assy.	1.5
Survival Kit - Collective (1)	56.0
Shoe Straps	2.0
Food Probe and Mouthpiece	4.0
Log Book, Pencils etc.	1.0
Hatch Egress	3.0
Lap Board (2)	2.0
Manual - Maint. Maps, & Case	6.0
Suit Umbilical Hose	10.0
In-Flight Test Maintenance Tool Belt	1.0
Structural Seats & Supports	258.0
Nuclear Radiation Detectors	7.0
In-Flight Maintenance Tool	1.0
Food Preparation Shelf	3.0
Personal Head Sets	<u>4.5</u>
 TOTAL CREW SYSTEMS	 512.0

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DETAIL WEIGHT STATEMENT
COMMAND MODULE
COMMUNICATIONS & INSTRUMENTATION

ITEM	CURRENT WEIGHT 2-1-63
TELECOMMUNICATIONS	
Lower Bay	(231.6)
C-Band Transponder	16.0
DSIF Trans.-Rec.	25.0
DSIF Power Amplifier	20.5
VHF FM Transmitter	5.7
VHF AM Trans.-Rec.	9.3
HF Transceiver	10.0
VHF Recovery Beacon	6.5
Multiplexer	9.0
Spares	19.0
PCM Telemetry Unit No. 1	26.0
PCM Telemetry Unit No. 2	25.0
Signal Conditioner	10.4
Input Analog Patch	2.6
Digital Patch Panel	4.0
Output Analog Patch	2.6
Recorder	15.0
Audio Center	5.0
Premodulation Processor	10.0
Central Timing Equipment	10.0
Remote Equipment	(148.4)
VHF/2-KMC OMNI Antenna & Transmission	59.0
HF Recovery Antenna & Transmission	15.0
C-Band Antenna & Transmission	18.0
VHF Recovery Antenna & Transmission	17.4
TV Camera	4.0
Instrumentation Sensors	35.0
Supports	(12.0)
Electrical Provisions	(96.0)
Electronic Interface Provisions	(8.0)
Cooling Provisions	(21.0)
 TOTAL TELECOMMUNICATIONS (to be brought forward)	 517.0

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DETAIL WEIGHT STATEMENT
COMMAND MODULE
COMMUNICATION AND INSTRUMENTATION

ITEM		CURRENT WEIGHT 2-1-63
CONTROLS AND DISPLAYS		
Main Display Panel Control Station		(60.5)
Integrated Display	C&I	10.0
GMT Clock	G&I	0.7
Computer Data Insert & Display	G&N	15.0
Time to & from Clock	G&N	1.5
SCS Control Panel	SCS	6.0
Delta Velocity Control	SCS	2.5
Flight Director Attitude Indicator	SCS	10.5
Gimbal Angle Indicator	SCS	2.0
Altimeter - Barometric	SCS	1.8
Survival Indicator	E&A	8.0
Master Caution Lights	U	2.5
 Main Display Panel Center Station		 (38.5)
Audio Panel	C&I	1.3
8 Day Clock	C&I	0.5
Indicator Light & Abort Light	U	0.7
Reaction Control System	U	7.0
Service Module Propulsion	U	7.0
Booster Situation Indicator	U	2.0
ECS - Gas Control	U	6.0
ECS - Liquid Control	U	6.0
Service Module Quad. Temp. Ind.		3.0
SCS Power Control		2.0
IFTS Scan Select		1.0
Loudspeaker		2.0
 Main Display Panel System Management Station		 (40.0)
Communications Control Panel	C&I	8.0
Antenna Control	C&I	3.0
Abort Light & Master Caution	U	2.7
Power Distribution	U	12.3
Fuel Cell Reactants	U	9.0
Cryogenic Storage	U	5.0
 Main Display Panel Installation Provisions		 (27.0)
 Main Display Right Hand Console	U	 (11.0)
Nuclear Detection Display		3.0
Installation Provisions		5.7
Lighting Control		1.0
Audio Panel		1.3
 Main Display Left Hand Console		 (12.0)
Installation Provisions		6.7
Lighting Control		1.0
Audio Panel		1.3
Boost Emergency, Earth Landing Sequence Control		3.0
Electrical Provisions		(29.0)
Environmental Provisions		<u>(9.0)</u>
 TOTAL CONTROLS AND DISPLAYS (to be brought forward)		 227.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULECOMMUNICATION AND INSTRUMENTATION

ITEM	CURRENT WEIGHT 2-1-63
IN-FLIGHT TEST (RIGHT BAY FORWARD)	(125)
Crew Readout Panel	3
Manual Test Unit	15
Comparator	12
Programmer	11
Stimuli Generator	24
Panel Assy	15
Installation Provisions & Connectors	5
In-Flight Test - GSE Electrical Provisions	40
CREW AREA CONTROLS	(15)
Manual Control - Three Axis	7
Manual Control - Translation & Thrust	8
TOTAL IN-FLIGHT TEST & CREW AREA CONTROLS	<u>140</u>
TOTAL CONTROLS AND DISPLAYS	227
TOTAL TELECOMMUNICATION	<u>517</u>
TOTAL COMMUNICATIONS AND INSTRUMENTATION	884

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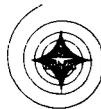
DETAIL WEIGHT STATEMENT

COMMAND MODULE

GUIDANCE & NAVIGATION

ITEM	CURRENT WEIGHT 2-1-63
<u>GUIDANCE & NAVIGATION</u>	
Lower Equipment Bay	
Inertial Platform	58.4
Sextant	12.0
Telescope - Scanning	9.0
Map & Visual Display	8.5
Display & Control - Navigation	39.5
Display & Control - Computer	15.0
Navigation Base	21.0
Computer	58.0
Power Servo Assy	29.0
Coupling Display Unit	15.0
Junction Box	11.0
Cabling - MIT	40.0
Cabling - NAA	16.6
Spares	40.0
Optical Base	19.0
Eye Pieces	5.0
Bellows and Adapter	<u>15.0</u>
 TOTAL GUIDANCE AND NAVIGATION	 412.0

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULESTABILIZATION AND CONTROL

ITEM	CURRENT WEIGHT 2-1-63
<u>STABILIZATION AND CONTROL</u>	
Lower Equipment Bay	(178.0)
Rate Gyro Package	6.5
Body Mounted Gyro Package	10.5
Electronic Control Package - Pitch	28.4
Electronic Control Package - Roll	29.1
Electronic Control Package - Yaw	28.4
Electronic Control Package - Auxiliary	30.5
Display/BMAG ECA Package	29.8
Spare Gyro - BMAG (2)	2.0
Spare Gyro - Rate	0.8
Spare Plug-in Module	12.0
Supports	(12.0)
Electrical Provisions	(16.0)
Environmental Control Provisions	(27.0)
TOTAL STABILIZATION AND CONTROL	<u>233.0</u>

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

REACTION CONTROL SYSTEM

ITEM	CURRENT WEIGHT 2-1-63
<u>REACTION CONTROL SYSTEM</u>	
Propellant System	(85)
Tanks	17
Expulsion Devices & Tank Supports	16
Plumbing, Fittings & Insulation	23
Valves & Regulators	21
Sensors	1
Supports - Plumbing & Equipment	7
Pressure System	(65)
Tanks (4500 psi)	9
Tank Supports	3
Plumbing, Fittings & Insulation	5
Valves & Regulators	39
Sensors	2
Helium	1
Supports - Plumbing & Equipment	6
Engine System	(121)
Engines	115
Supports	6
Electrical Provisions	<u>(23)</u>
TOTAL REACTION CONTROL SYSTEM	294

~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTCOMMAND MODULEELECTRICAL POWER

ITEM	CURRENT WEIGHT 2-1-63
<u>ELECTRICAL POWER</u>	
Energy Source	(60.0)
Battery - Main (2)	36.0
Battery - Recovery (1)	18.0
Installation Provisions (Cold Plates)	6.0
Power Conversion	(107.6)
Inverter (3)	90.0
Inverter Controls	3.0
Battery Charger & Controls	5.0
Installation Provisions (Cold Plates)	9.6
Power Distribution & Control	(162.0)
Power Distribution Equipment	
Circuit Breakers	6.0
Battery Controls	5.0
No. 1 and No. 2 AC Bus Control	15.0
DC Busses (Diodes, etc.)	10.0
AC Busses	5.0
Utility System Controls	15.0
Mounting Hardware	2.0
Sequencer	10.0
Right Hand Circuit Breaker Panel	13.0
Terminal Panels	5.0
Power Distribution Wiring & Provisions	40.0
Lighting Wiring & Provisions	5.0
Ground Power Provisions	6.0
Power Control Panel Connectors	3.0
Installation Provisions	22.0
Electrical - Common Utility	(87.4)
Utility Wiring and Circuit Components	20.0
Left Hand Circuit Breaker Panel	7.0
Umbilicals	35.0
Posigrade Adapter Separation System	10.0
Launch Escape System Separation	5.0
Service Module Electrical Initiation	5.0
Installation Provisions	<u>5.4</u>
TOTAL ELECTRICAL POWER	417.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

ENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 2-1-63
<u>ENVIRONMENTAL CONTROL SYSTEM</u>	
Pressure Suit Circuit	(76.3)
Subcontractor Components	64.2
Ducting, Conn., Clamps, etc.	12.1
Water-Glycol Circuit	(49.7)
Subcontractor Components	27.7
Water-Glycol	18.4
Plumbing, etc.	3.6
Pressure & Temp. Control	(16.6)
Subcontractor Components	15.8
Ducting	0.8
Oxygen Supply System	(14.7)
Subcontractor Components	11.7
Plumbing	3.0
Water Supply System	(28.5)
Subcontractor Components	23.7
Plumbing	4.8
Subcontractor Common Items	(41.2)
Brackets, Plumbing, Elect. Wiring	16.6
Instrumentation	14.6
Radio Noise Filter Spec. Allowance	10.0
Gas Analyzer (NASA)	(7.0)
Supports	(10.0)
Electrical Provisions	<u>(21.0)</u>
 TOTAL ENVIRONMENTAL CONTROL SYSTEM	 265.0

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ITEM	CURRENT WEIGHT 2-1-63
<u>EARTH LANDING SYSTEM</u>	
Parachute System	(525.9)
Drogue Chute System	36.2
Drogue Disconnect Inst.	7.9
Main Cluster	412.5
Disconnect Main Cluster	9.7
Pilot Chute System	29.2
Sequence Control	25.4
Attach Provisions	5.0
Location Aids	(9.1)
Forward Heat Shield Release System	(16.0)
Electrical Pyrotechnic Initiation Provisions	<u>(5.0)</u>
TOTAL EARTH LANDING SYSTEM	556.0

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DETAIL WEIGHT STATEMENT

COMMAND MODULE

USEFUL LOAD

ITEM	CURRENT WEIGHT 2-1-63
<u>CREW SYSTEMS</u>	(772)
Crew (3) (50, 70, 90, Percentile)	528
Pressure Garment Assy (3) (NASA)	90
Food	75
Food Containers	15
Water - Survival	18
Personal Hygiene Equipment	23
Biomedical Instrumentation (NASA)	2
Medical Equipment	17
Chemical Disinfectant	4
<u>REACTION CONTROL</u>	(242)
RCS Propellant	242
<u>ENVIRONMENTAL CONTROL</u>	(151)
Lithium Hydroxide	112
Activated Charcoal	4
Containers for LiOH & Charcoal	6
Oxygen - Re-entry	2
Water-Launch & Re-entry Cooling	10
Freon	10
Water-Earth Orbit Cooling	7
<u>SCIENTIFIC PAYLOAD</u>	(250)
TOTAL COMMAND MODULE USEFUL LOAD	1415

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ITEM		CURRENT WEIGHT 2-1-63
<u>WEIGHT EMPTY</u>		7679
Structure	2623	
Electronics	166	
Reaction Control	599	
Electrical Power	1151	
Environmental Control	78	
Propulsion	3062	
<u>USEFUL LOAD</u>		2241
Reaction Control	835	
Electrical Power	482	
Environmental Control	208	
Propulsion	716	
BURNOUT WEIGHT		9920
MAIN PROPELLANT - MAXIMUM USABLE CAPACITY		45000
GROSS WEIGHT		<u>54920</u>

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

STRUCTURE

ITEM	CURRENT WEIGHT 2-1-63
STRUCTURE	
Basic & Secondary Structure	
Radial Beams	477
Internal Structure & Engine Compartment Closeout	45
Outer Shell	920
Fairing - Command to Service	200
Engine Support	41
Antenna Support Structure	30
Forward Bulkhead Including Ring	148
Aft Bulkhead	478
Separation Provisions	20
Tank Support Shelf	30
Insulation	<u>234</u>
 TOTAL STRUCTURE	 2623
	257
	2387

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DETAIL WEIGHT STATEMENT

SERVICE MODULE

ELECTRONIC SUBSYSTEMS

ITEM	CURRENT WEIGHT 2-1-63
<u>ELECTRONICS SUBSYSTEM</u>	
Communications	(72)
Antenna Dish	10
Antenna Gimbals	13
Antenna Deployment Booms	25
Antenna Coax Cabling	16
Antenna Coax Supports	3
Antenna Control Electrical Provisions	5
Instrumentation	(64)
Sensors	30
Electrical Provisions	14
Supports	5
Signal Conditioner	15
In-Flight Test Provisions	(30)
In-Flight Test & GSE Electrical Provisions	30
TOTAL ELECTRONICS SUBSYSTEMS	<u>166</u>



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DETAIL WEIGHT STATEMENT

SERVICE MODULE

REACTION CONTROL

ITEM	CURRENT WEIGHT 2-1-63
<u>REACTION CONTROL SYSTEM</u>	
Propellant System	(149)
Tanks	43
Expulsion Devices & Tank Supports	35
Plumbing, Fittings & Insulation	17
Valves & Regulators	32
Sensors	6
Supports - Plumbing & Equipment	16
Pressure System	(133)
Tanks (4500 psi)	19
Tank Supports	6
Plumbing, Fittings & Insulation	6
Valves & Regulators	76
Sensors	9
Helium	3
Supports - Plumbing & Equipment	14
Engine System	(179)
Engines	69
Reflectors & Insulation	110
Structural Provisions	(80)
Electrical Provisions	<u>(58)</u>
TOTAL REACTION CONTROL SYSTEM	599

~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEELECTRICAL POWER

ITEM	CURRENT WEIGHT 2-1-63
<u>ELECTRICAL POWER</u>	
Fuel Cell Power System	(1068.2)
Fuel Cell Power Pack (Incl. Mount)	732.0
Intermodular - Radiator Plumbing	12.0
Fuel Cell Module Mount Attach.	2.0
Fuel Cell H ₂ System	
Subcontractor Components	121.2
Plumbing and Valves	3.0
Fuel Cell and ECS O ₂ System	
Subcontractor Components	164.6
Plumbing and Valves	4.0
Water Glycol - Fuel Cell Heat Transfer System	7.0
Elect. Wiring - Supercritical Gas	13.0
Space Radiator (Outer Skin)	9.4
Power Distribution	(50.8)
Relays & Diodes	10.0
Power Switch	5.4
Motor Switch	1.5
Umbilicals	14.4
Wiring & Busses	15.0
Supports	4.5
Electrical Utilities	(32.0)
Command - Service Separation System	3.0
Adapter Separation System	10.0
Electrical Initiation of Pyrotechnics	17.0
Supports	2.0
 TOTAL ELECTRICAL POWER	 <u>1151.0</u>

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEENVIRONMENTAL CONTROL SYSTEM

ITEM	CURRENT WEIGHT 2-1-63
<u>ENVIRONMENTAL CONTROL SYSTEM</u>	
Water-Glycol Circuit - Airesearch	(26.6)
Subcontractor Components	8.5
Plumbing and Hardware	4.4
Radiator Provisions	5.6
Water - Glycol	3.4
Supports	4.7
Water Supply System	(7.5)
Subcontractor Components	0.6
Plumbing and Hardware	6.0
Supports	0.9
Oxygen Supply System	(3.4)
Plumbing and Supports	3.0
Subcontractor Components	0.4
Subcontractor Common Supports	(0.5)
Electrical Provision	(23.0)
Space Radiator (Outer Skin)	<u>(17.0)</u>
 TOTAL ENVIRONMENTAL CONTROL SYSTEM	 78.0

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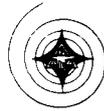
DETAIL WEIGHT STATEMENT

SERVICE MODULE

MAIN PROPULSION

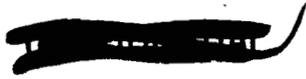
ITEM	CURRENT WEIGHT 2-1-63
<u>MAIN PROPULSION</u>	
Propellant System	(1455)
Tanks & Integral Doors	990
Tank Skirts	200
Plumbing, Fittings & Insulation	95
Valves	9
Quantity Indication	70
Mixture Ratio Control	12
Supports - Plumbing & Equipment	79
Pressure System	(941)
Tanks (4500 psi)	800
Tank Supports	30
Plumbing, Fittings & Insulation	24
Valves, Regulators & Heat Exchanger	49
Supports - Plumbing & Equipment	38
Engine System	(640)
Engine	640
Electrical Provisions	<u>(26)</u>
TOTAL MAIN PROPULSION SYSTEM	3062

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~~CONFIDENTIAL~~DETAIL WEIGHT STATEMENTSERVICE MODULEUSEFUL LOAD

ITEM	CURRENT WEIGHT 2-1-63
REACTION CONTROL	(835)
Useful Reaction Control System Propellant	790
Unusable Reaction Control System Propellant	45
ELECTRICAL POWER	(483)
Usable Supercritical Reactants	
Hydrogen (incl. 10% reserve)	46
Oxygen (incl. 10% reserve)	365
Unusable Supercritical Reactants	
Hydrogen	10
Oxygen	62
ENVIRONMENTAL CONTROL	(207)
Oxygen - ECS	207
PROPULSION	(716)
Main Propulsion Helium	99
Main Propellant Residuals	617
Trapped - System	225
Trapped - Engine	67
Mixture Ratio Tolerance	100
Loading Tolerance	225
TOTAL USEFUL LOAD	2241
(LESS MAIN PROPELLANT)	

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DETAIL WEIGHT STATEMENT

LAUNCH ESCAPE SYSTEM

SUMMARY

ITEM	CURRENT WEIGHT 2-1-63
<u>LAUNCH ESCAPE SYSTEM</u>	
Structure	(1072)
Tower Assy	272
Flow Separator and Skirt	297
Jettison Motor Skirt	94
Pitch Motor Structure	157
Nose Cone and Ballast Support	111
Attaching Parts	25
Tower Insulation	45
Skirt Insulation	26
Flow Separator Insulation	45
Ballast	(79)
Propulsion	(5259)
Escape Motor	4764
Jettison Motor	440
Pitch Control Motor	55
Electrical Power	<u>(20)</u>
 TOTAL LAUNCH ESCAPE SYSTEM	 6430

1072
116

956



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DETAIL WEIGHT STATEMENT

ADAPTER

SUMMARY

ITEM	CURRENT WEIGHT 2-1-63
ADAPTER	
Structure	(2892)
Panels	1915
Frames	421
Thermal Insulation	556
Electrical Power	(76)
Separation System	<u>(142)</u>
TOTAL ADAPTER	3110

2892
556
2830

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